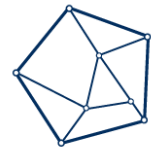




THE UNIVERSITY OF  
**SYDNEY**

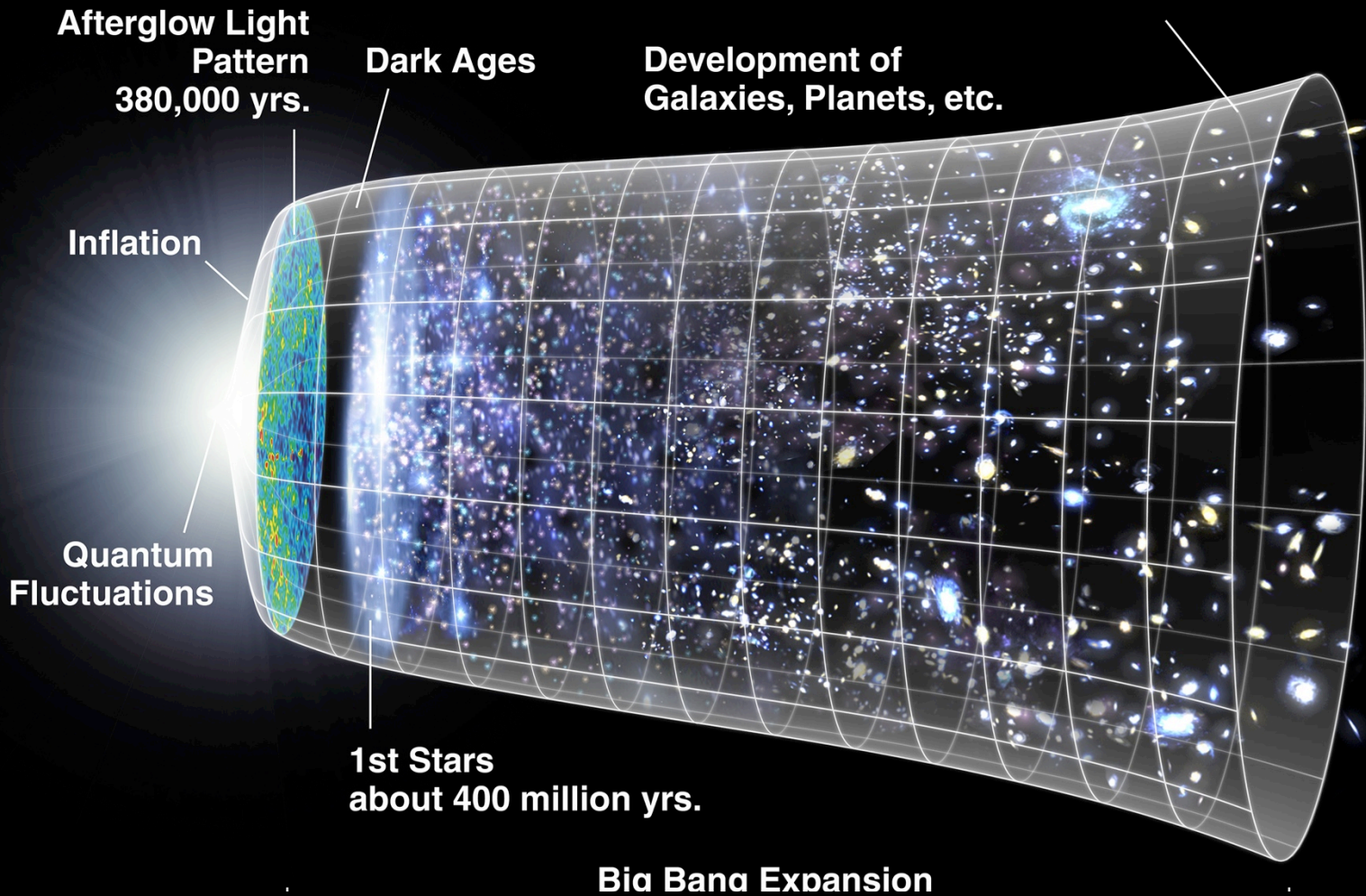


**CAASTRO**  
ARC CENTRE OF EXCELLENCE  
FOR ALL-SKY ASTROPHYSICS

# Cosmic Engines

Dr Jamie Farnes

Postdoctoral Researcher, University of Sydney



**Afterglow Light  
Pattern  
380,000 yrs.**

**Dark Ages**

**Development of  
Galaxies, Planets, etc.**

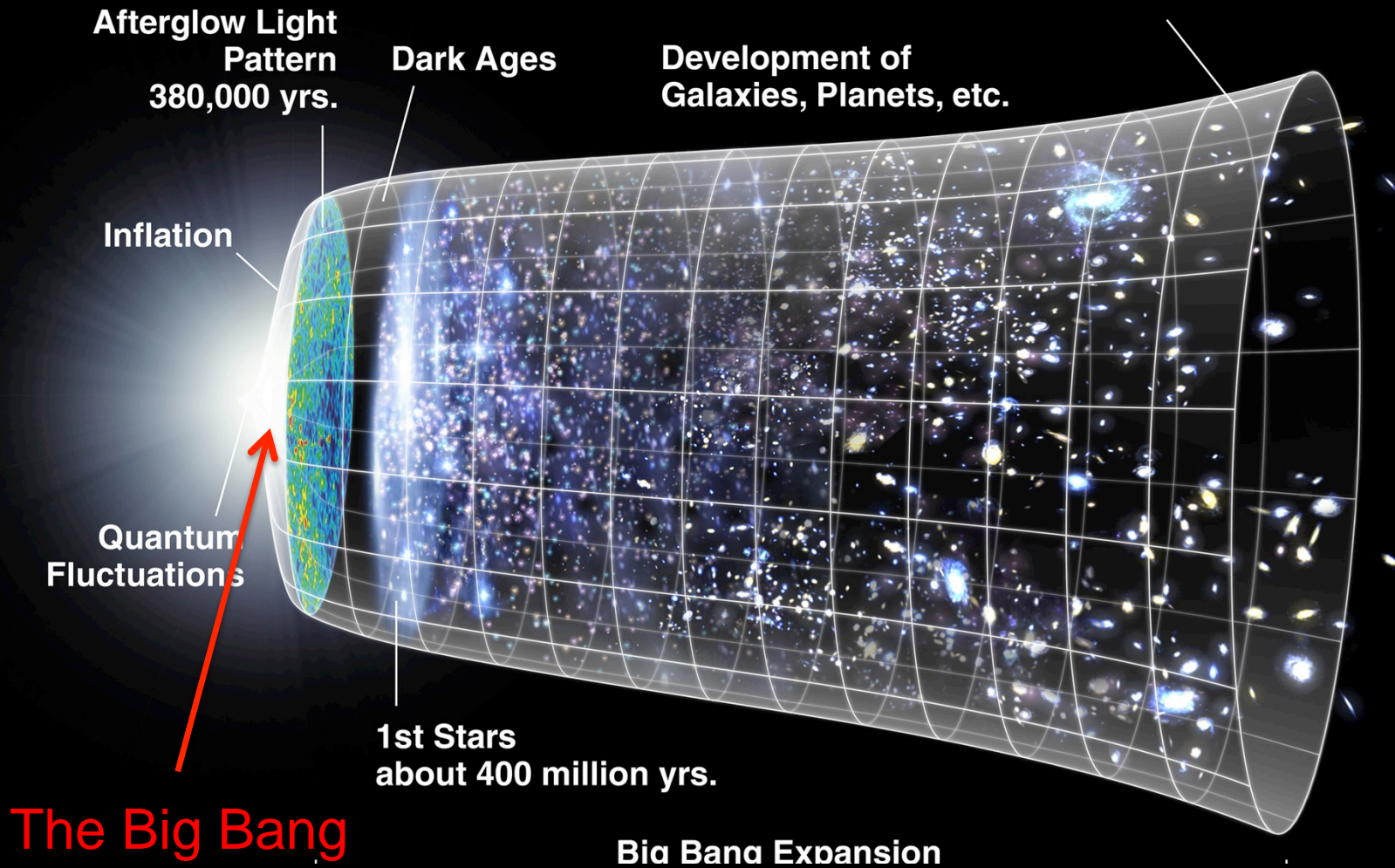
**Inflation**

**Quantum  
Fluctuations**

**1st Stars  
about 400 million yrs.**

**Big Bang Expansion**

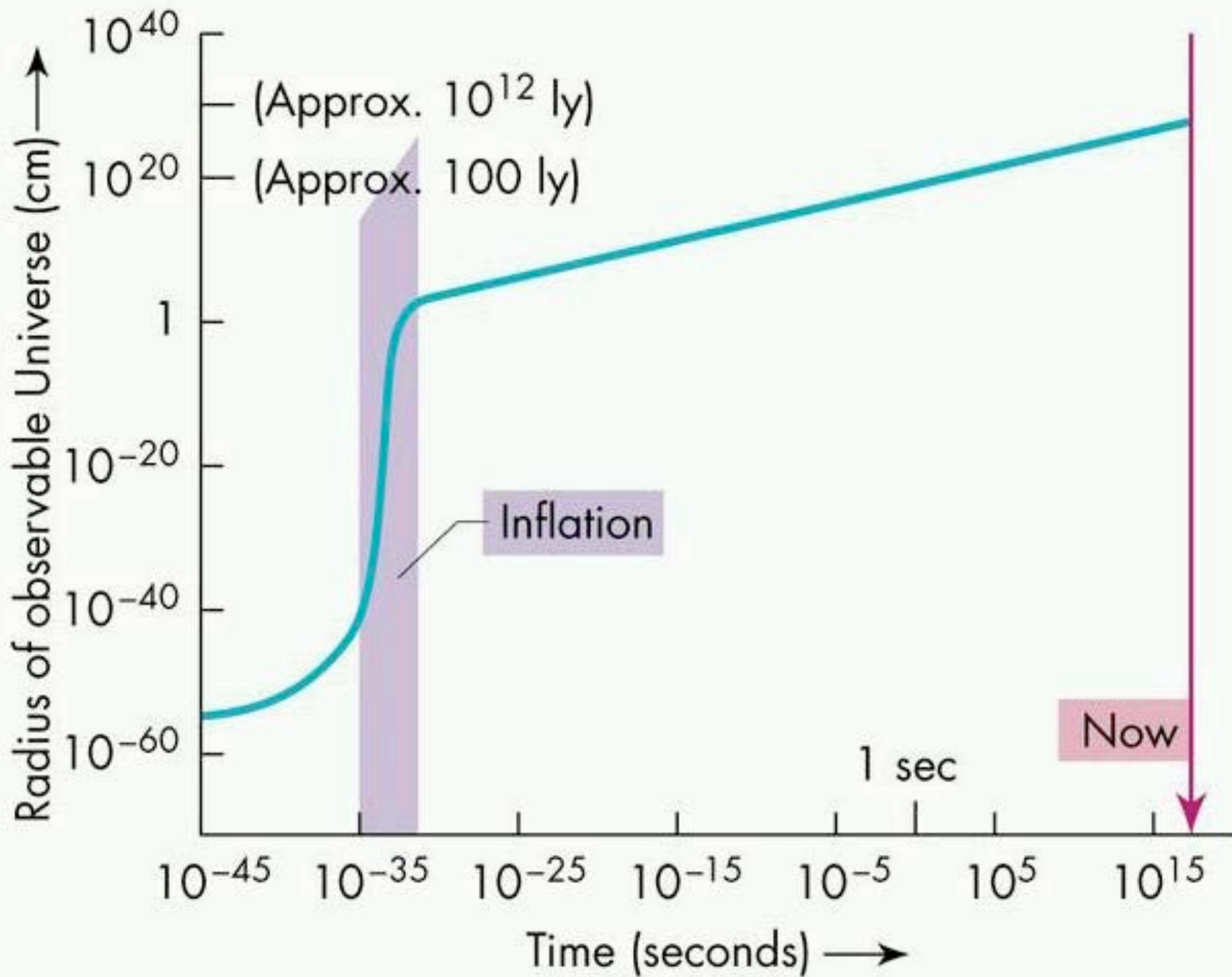






# The Big Bang

- We still don't know what happened before the Big Bang, or what caused it.
- Just after the Big Bang, the Universe was very hot and filled with radiation.
- Expanded extremely rapidly for a tiny fraction of a second – Inflated like a balloon.

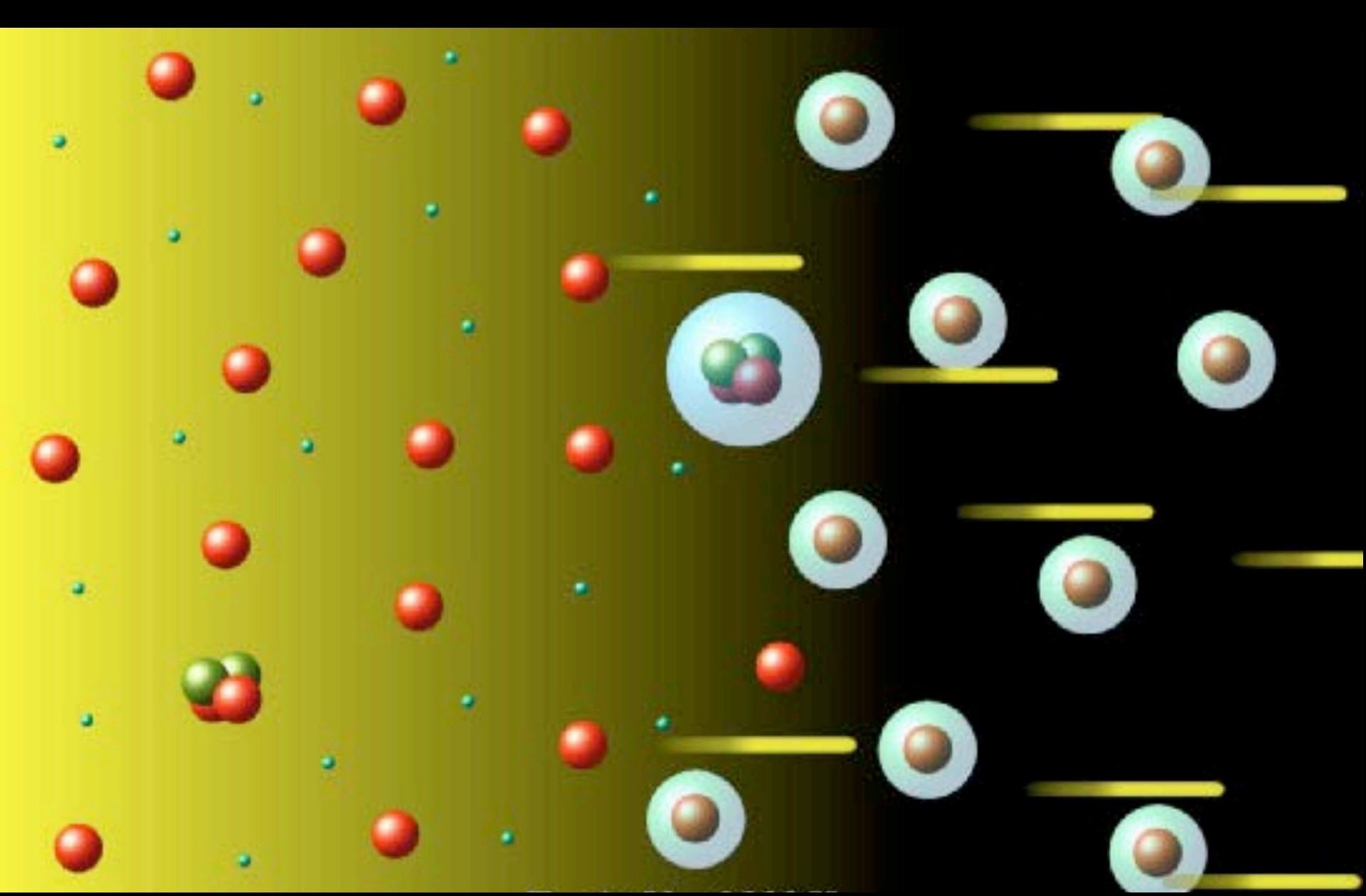




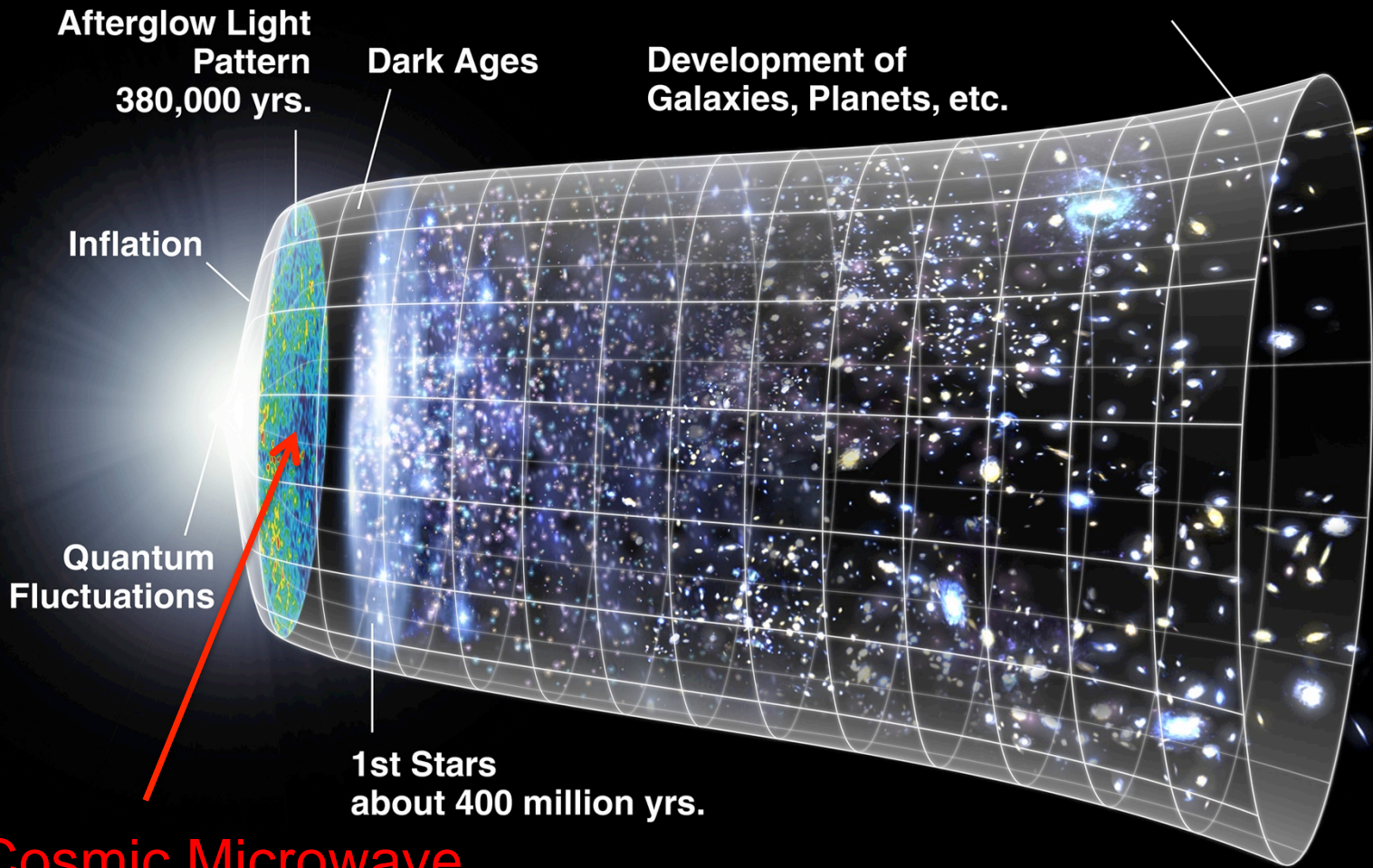


# The Big Bang

- We still don't know what happened before the Big Bang, or what caused it.
- Just after the Big Bang, the Universe was very hot and filled with radiation.
- Expanded extremely rapidly for a tiny fraction of a second – Inflated like a balloon.
- Universe began to cool down and form the first sub-atomic particles (electrons, protons, and others).



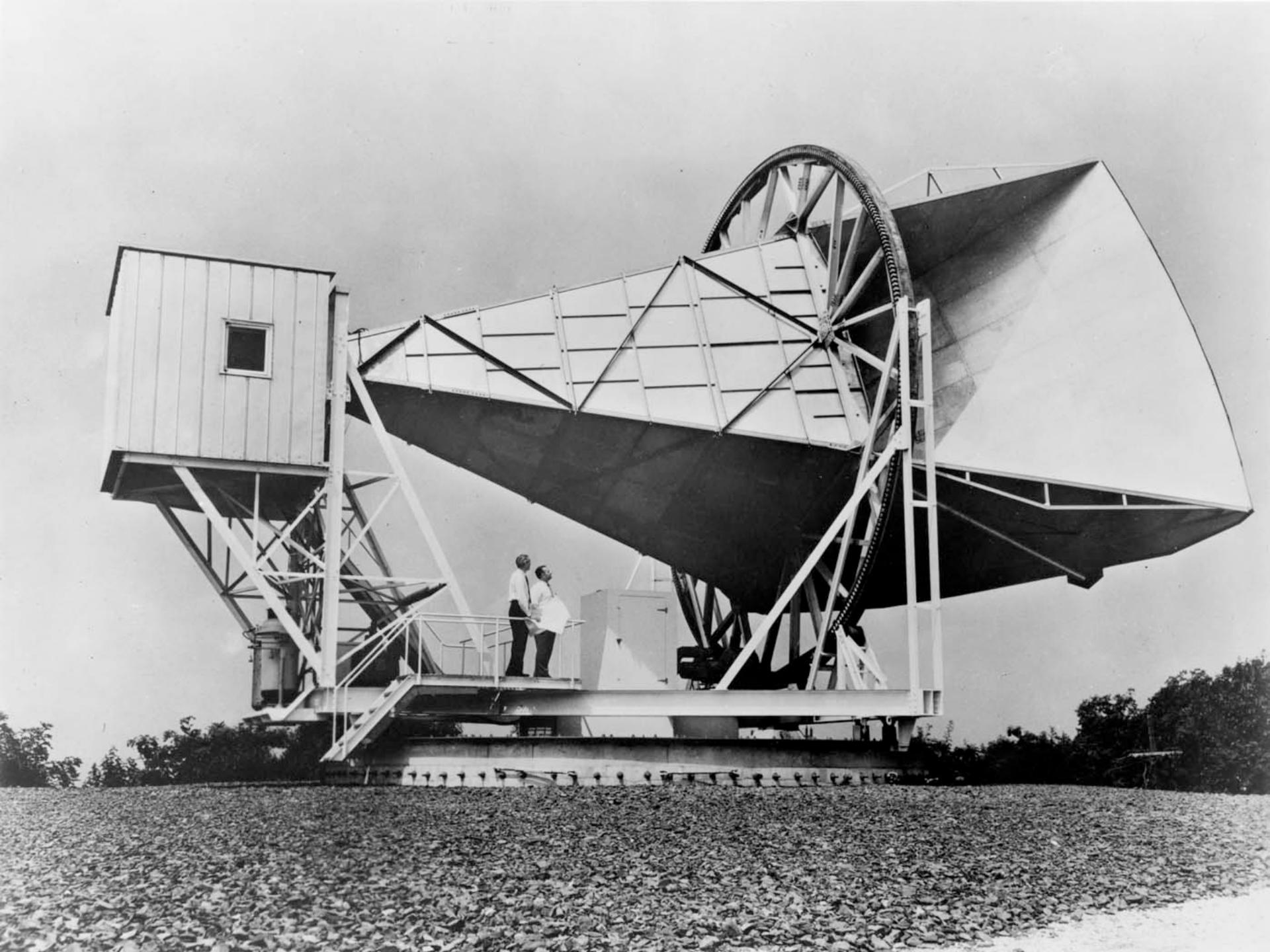
Time (Universe expanding and cooling down)

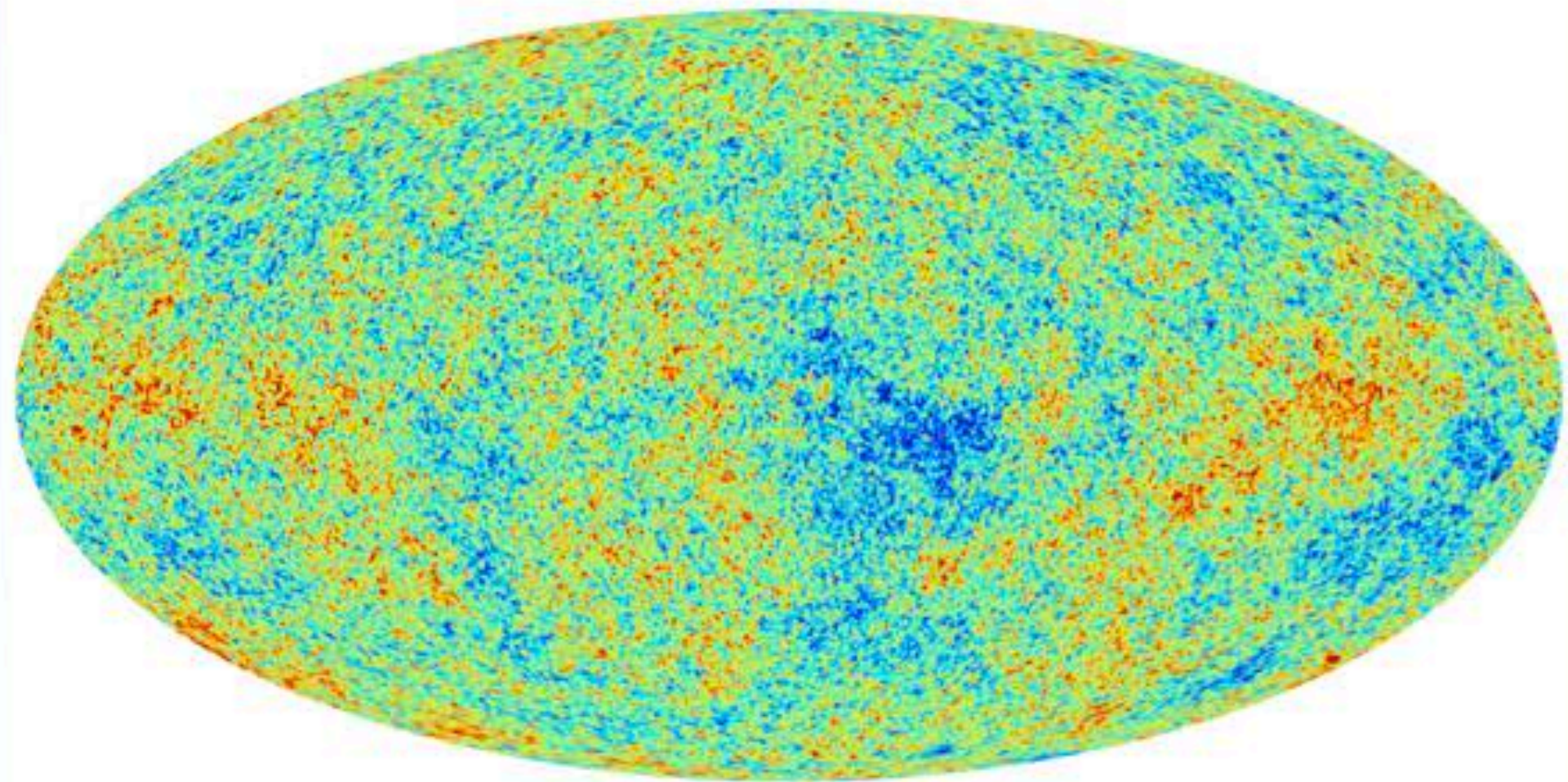


**“Cosmic Microwave Background” (CMB)**

**Big Bang Expansion**



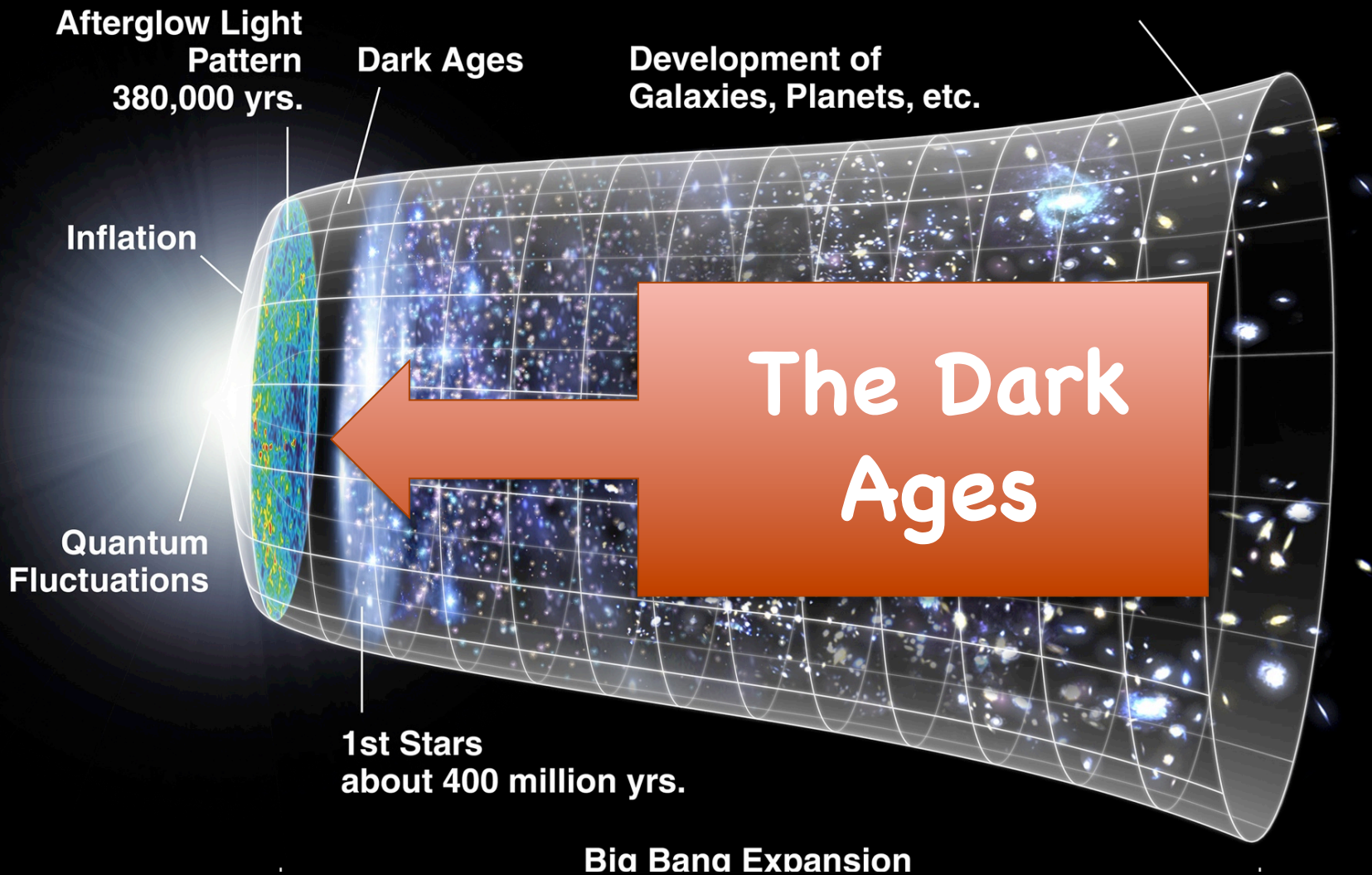


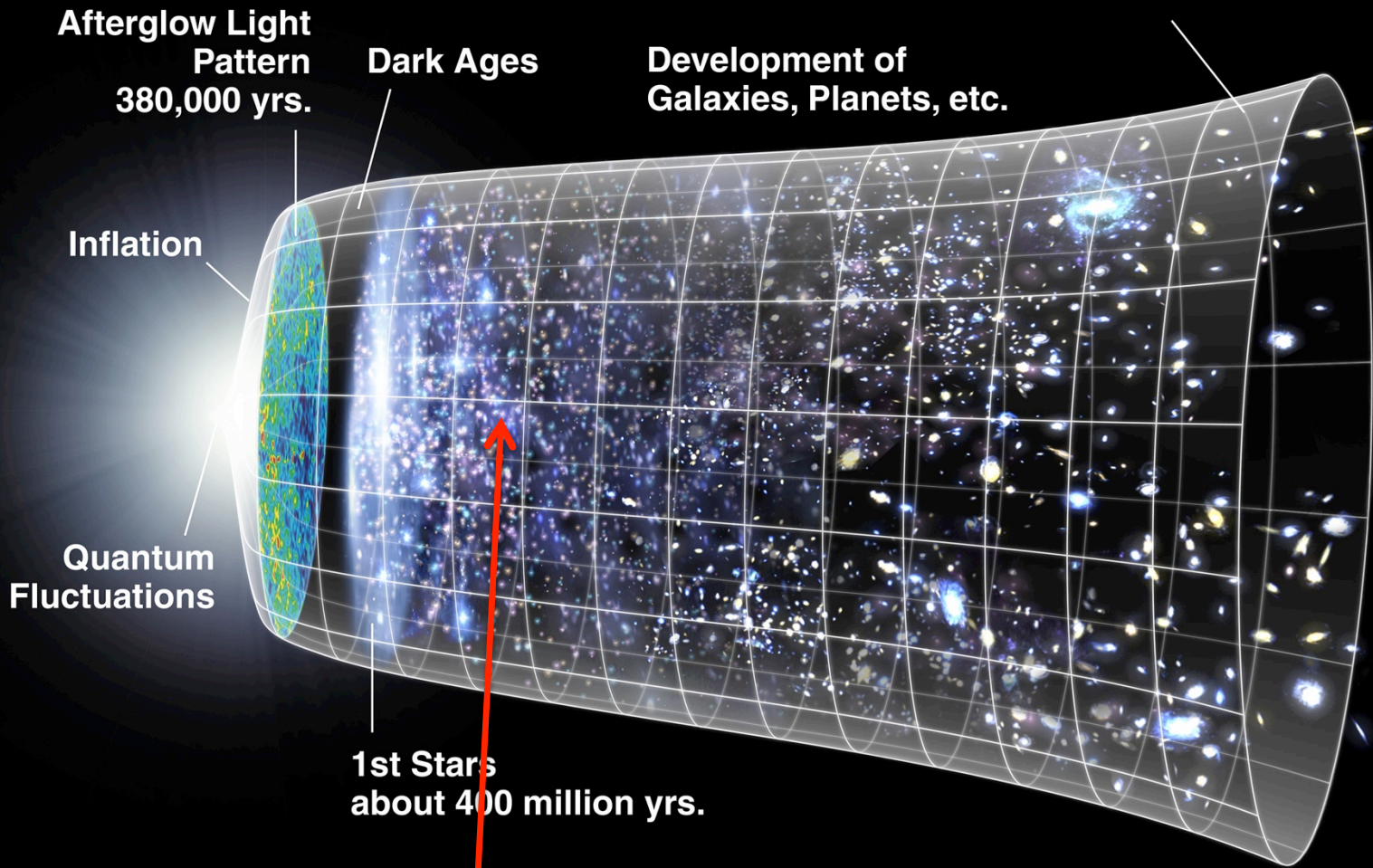












**Bia Band Expansion**

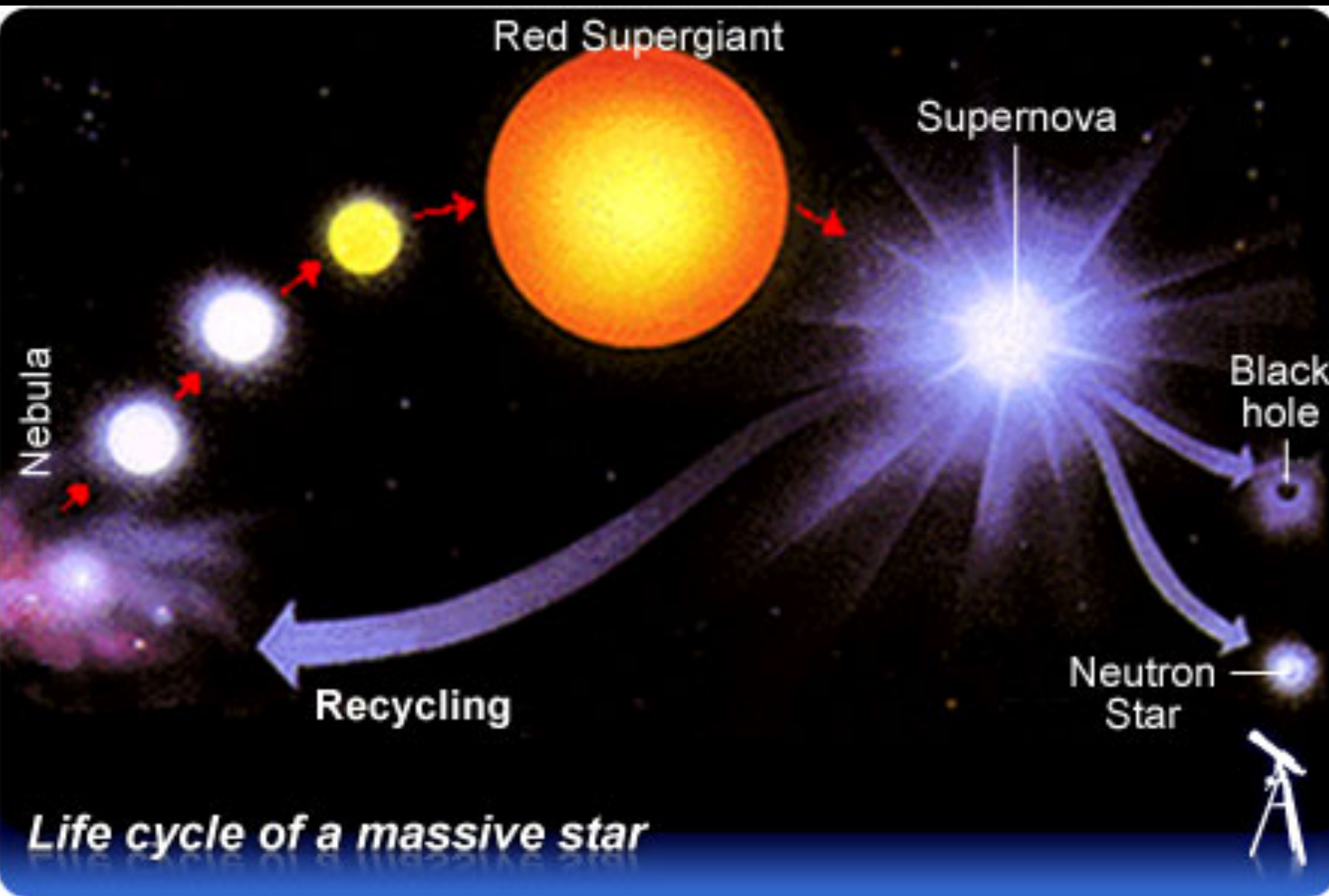
# The Early Universe



# The Early Universe

- The Universe was almost entirely Hydrogen, with a small number of slightly heavier elements.
- The first stars were formed from giant clouds of Hydrogen.
- The nuclear fusion process inside stars created heavier and heavier elements when they exploded (Supernovae).





*Life cycle of a massive star*







A visualization of the Cosmic Microwave Background (CMB) radiation, showing a bright, glowing horizon line against a dark background. On the left, a large, glowing sphere, likely representing the Earth or a similar planet, is shown with a fiery, orange and red surface. The CMB radiation is depicted as a bright, white and yellowish glow that fades into the dark background, with some faint, wispy structures visible. The overall scene is set against a dark, starry background, suggesting a cosmic or space environment.

# Quick quiz!

What is the temperature of the Cosmic Microwave Background?

What is the Cosmic Microwave Background incredible evidence for?

How are the heavy elements made?





# Quick quiz!

What is the temperature of the Cosmic Microwave Background?

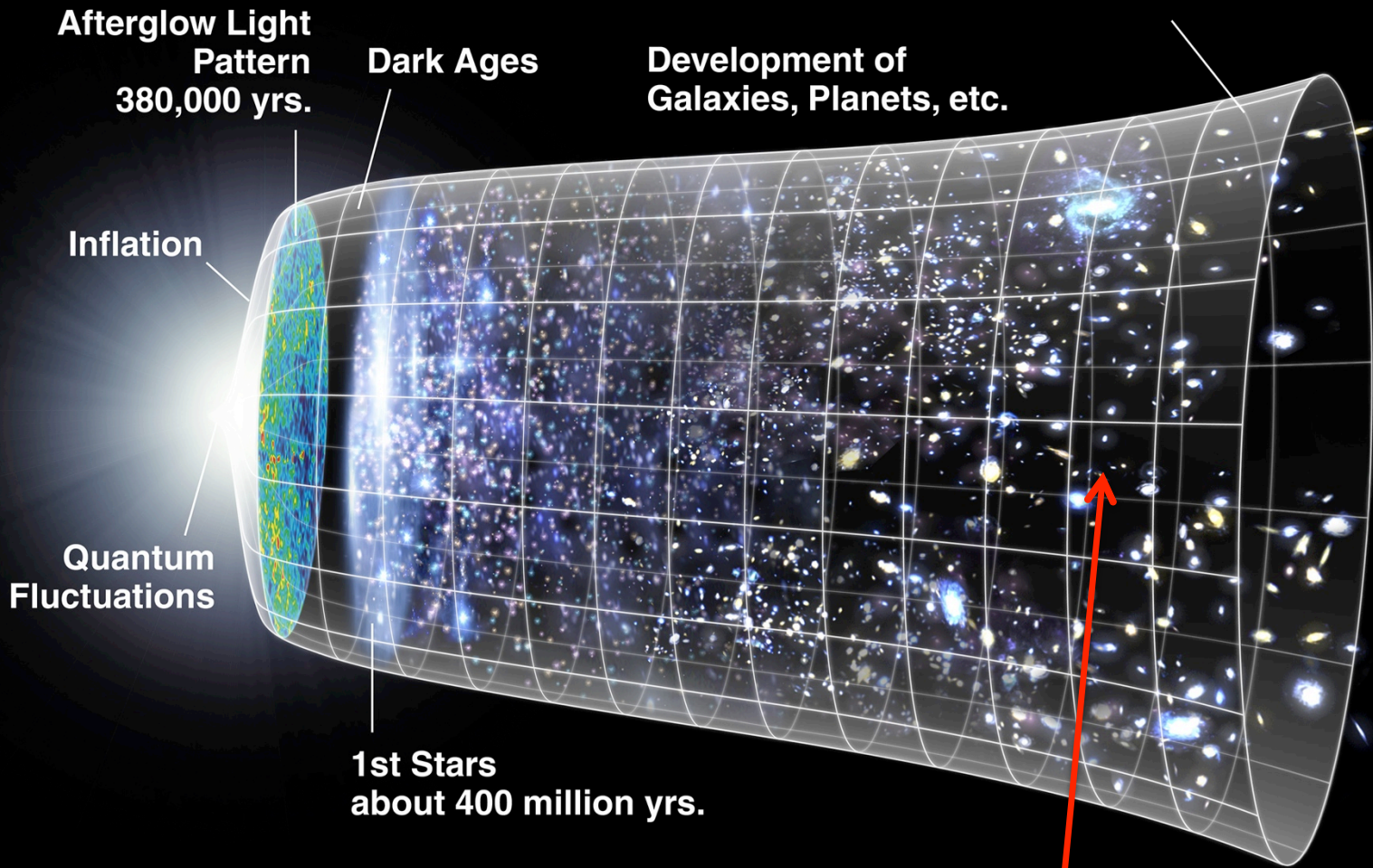
**-270°C.**

What is the Cosmic Microwave Background incredible evidence for?

**The Big Bang! Without a Big Bang, cannot explain the existence of the CMB.**

How are the heavy elements made?

**Nuclear fusion in stars and supernovae.**



Afterglow Light  
Pattern  
380,000 yrs.

Dark Ages

Development of  
Galaxies, Planets, etc.

Inflation

Quantum  
Fluctuations

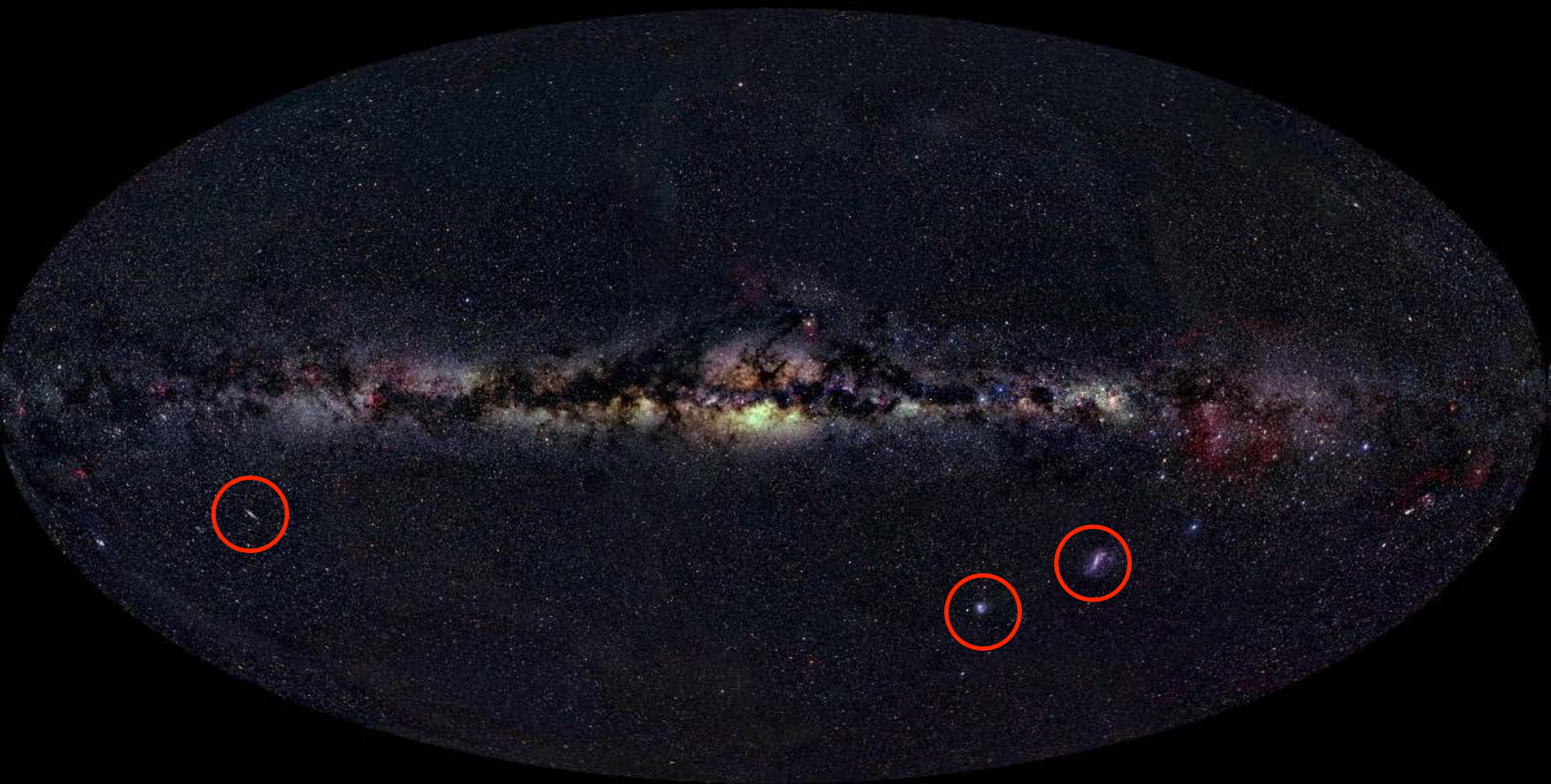
1st Stars  
about 400 million yrs.

Bia Band Expansion

The Local Universe



*Visible Light*





Andromeda



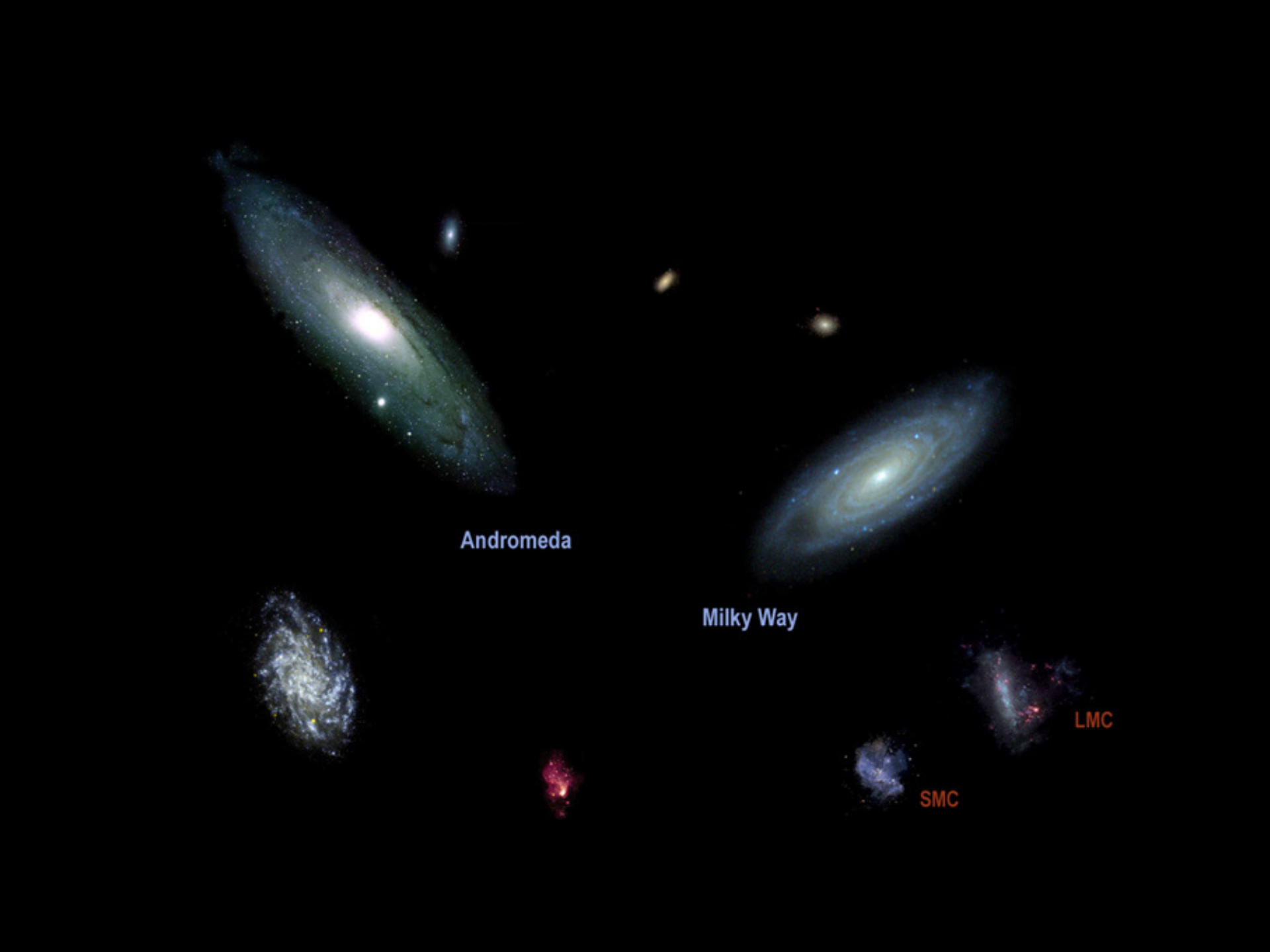
Milky Way



LMC



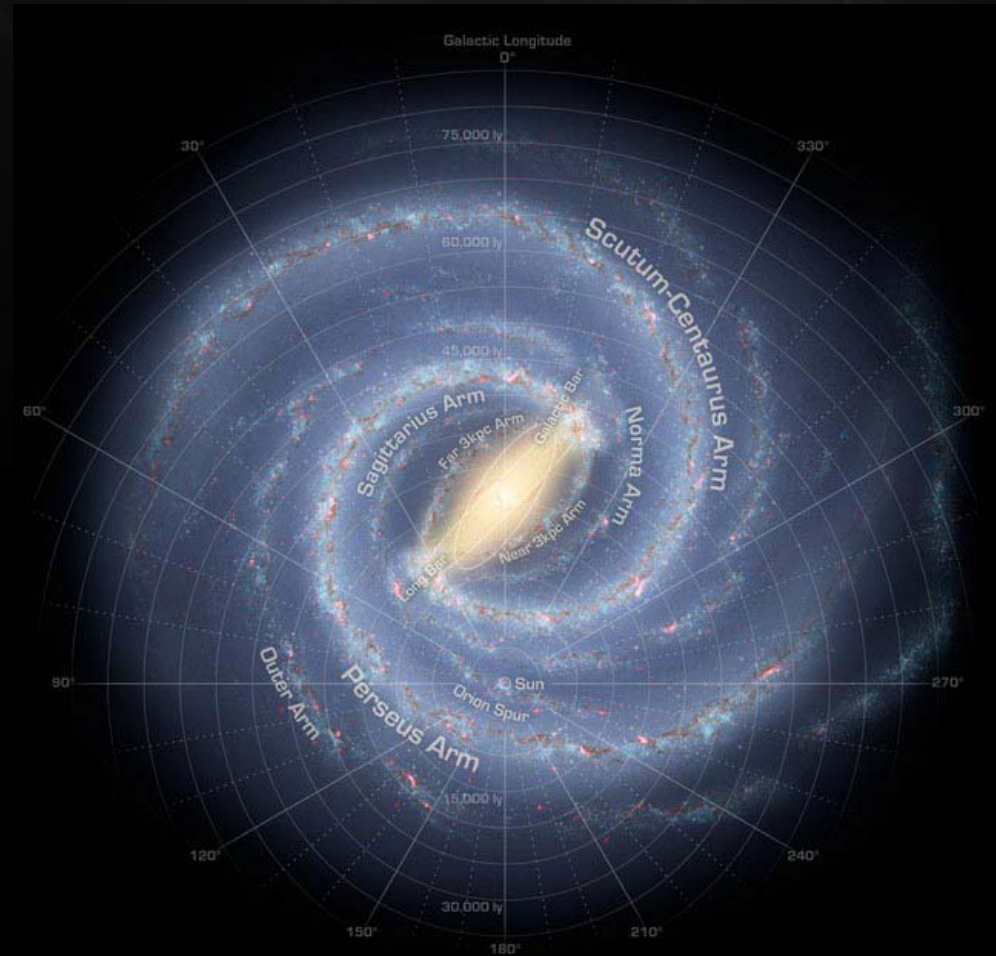
SMC





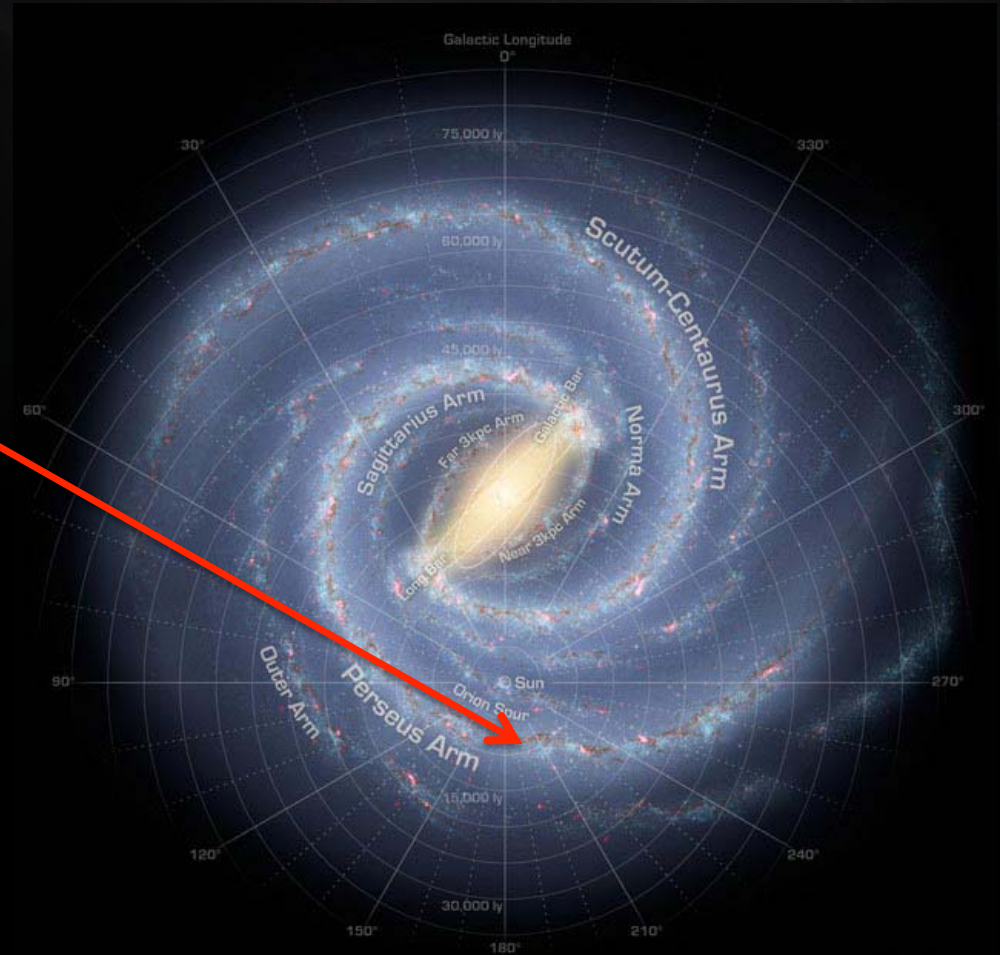
# The Milky Way

- 100,000 light years in diameter.
- 1,000 light years thick.
- Gas, dust, and black holes.
- 300 billion stars.
- How many planets?



# The Milky Way

Our Solar System  
\* You are here!







**1,000,000,000,000,000,000**



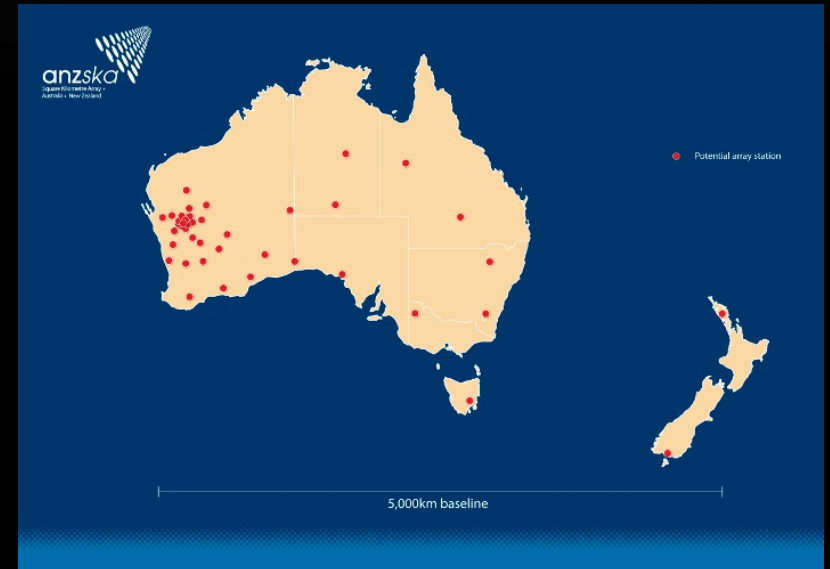


# The Future

- We need a better telescope!
  - The Square Kilometre Array (SKA)
  - \$2 billion dollar international project scheduled for construction in 2016, and operational by 2024.
  - Based in both Australia and South Africa.
  - Capable of observing the *entire* sky several times in one day.

# The Square Kilometre Array

- › 1,000,000 m<sup>2</sup> of collecting area.
- › Sensitive enough to observe the first stars and galaxies in the “Dark ages”.
- › Will be able to detect an airport radar on a planet 50 light years away.





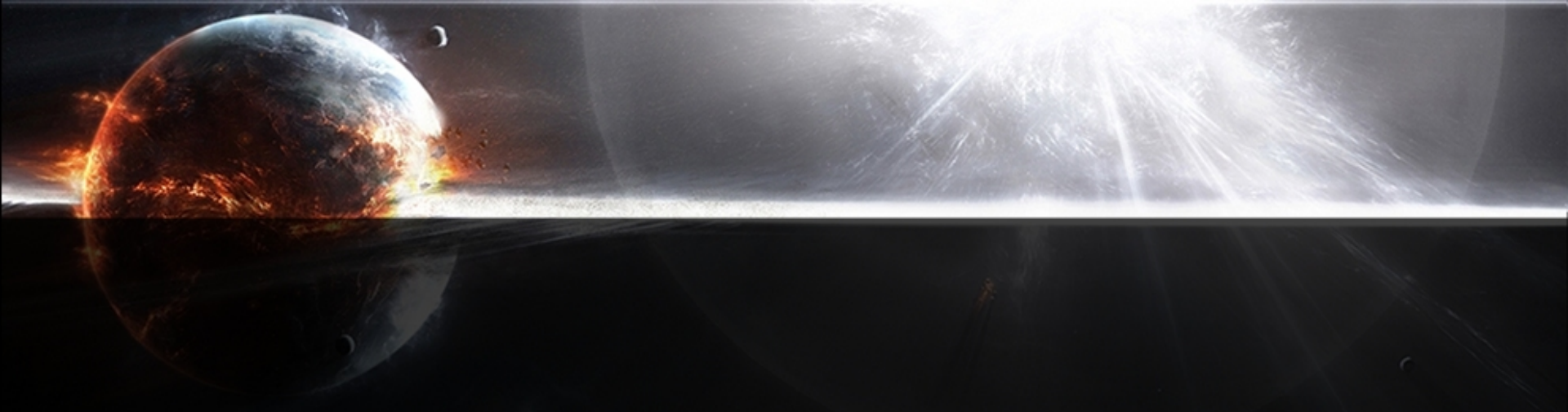


# The SKA

- A huge technology driver.
- Will produce 10 times as much data as the current global internet traffic.
- Enough data to fill 15 million 64GB iPods. Every day!
- Need a computer 100 times faster than any existing computer.







Thank you for listening!  
Questions??